PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 61.S3502WO17	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/IB 03/03207	International filing date *(day/month/year)* 30.07.2003	Priority date *(day/month/year)* 02.08.2002
International Patent Classification (IPC) or both national classification and IPC F04D29/28		
Applicant SPAL S.R.L. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
19.02.2004	27.10.2004
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Avramidis, P Telephone No. +49 89 2399-7317

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IB 03/03207

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

Description, Pages

1, 2, 6, 7	as originally filed
3-5	received on 27.09.2004 with letter of 23.09.2004

Claims, Numbers

1-8	received on 27.09.2004 with letter of 23.09.2004

Drawings, Sheets

1/6-6/6	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

   ☐ the language of publication of the international application (under Rule 48.3(b)).

   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.

   ☐ filed together with the international application in computer readable form.

   ☐ furnished subsequently to this Authority in written form.

   ☐ furnished subsequently to this Authority in computer readable form.

   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:

   ☐ the claims, Nos.:

   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-8
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-8
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-8
	No:	Claims	

2. Citations and explanations

   see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

D1: US-A-2 980 990
D2: US-A-1 478 909
D3: US2002/021967

The present invention relates to an impeller for a centrifugal fan according to the preamble of claim 1.

Such impellers are known from, for example document D1. The known impellers, although they may be effective in noise reduction, it is difficult to make by plastic injection moulding due to undercuts. They are either made from metal sheet in a composite way (D2) or produced with an integral forming method (D3).

The present invention has the aim to provide an improved, low-noise centrifugal fan impeller with inclined blades with improved performance in terms of pressure head and capacity and which at the same time is easy to construct.

With the characterising features of claim 1, the impeller of the present invention does not present any undercut. In particular, the ring 5 does not interfere with the blades, moreover the ring is positioned on an outer diameter in respect to the blades so that the inner part of the mould can be extracted axially from both sides of the fan impeller.

None of the prior art documents which have become known to this Authority discloses all the technical features of independent claim 1.

Furthermore, the solution to the above mentioned problem in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) since it is not taught or suggested by the prior art documents.

Claims 2-8 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

Therefore, the present application meets the requirements of Article 33(2) and (3) PCT, because the subject-matter of claims 1-8 is new and involves an inventive step.

the chord (L) is the length of the line joining the ends of the arc extending from the leading edge to the trailing edge for an aerodynamic profile of the blade section at the intersection between the blade and a plane perpendicular to the axis of rotation of the impeller;

the centre line (MC) of the blade is the line joining the midpoints of the chords L at the different radiuses;

the inclination (α) of the blade is the angle made by the centre line (MC) of the blade and the axis of the impeller;

the camber (f) is the longest perpendicular line to the chord (L), measured from the chord (L) to the profile or camber line of the blade; the position of the camber (f) relative to the chord (L) may be expressed as a percentage of the length of the chord itself.

With reference to Figures 1 and 2 of the accompanying drawings, the numeral 1 denotes in its entirety the impeller according to the invention.

The impeller 1 may consist of two or more modules 2, each of which comprises a plurality of blades 3 extending between a mounting disc 4 and at least one connecting ring 5. The blades 3 are connected to these components at an angle α relative to the axis 6 of the impeller 1. The angle α may range from 5 to 30 ~~(sexagesimal)~~ degrees and is preferably 10 degrees.

The blades 3 of two adjacent modules 2 may be inclined in the same direction or in opposite directions. Further, the blades 3 of one module 2 are preferably offset with respect to those of the adjacent module 2, that is to say, the end of one blade 3 of one module 2 is approximately half way along the space between two blades 3 of the adjacent module 2.

In one preferred embodiment, the impeller 1 is designed to be mounted in a centrifugal fan which sucks fluid in from both sides.

In another embodiment which is not illustrated, air is sucked in from only one side of the fan, whilst the blade 3 mounting disc 4 is located on the opposite side to that were air is sucked in. In the latter case, the impeller 1 may comprise two or more modules 2 placed side by side.

The geometrical characteristics of each blade 3 are illustrated in Figures 3 to 5.

Figure 3 illustrates a blade 3 in a straightened plan view. The blade 3 is basically trapezoidal in shape but it might also be rectangular to enhance capacity compared to head.

The blade 3 comprises a straight leading edge A, inclined at an angle β relative to the axis 6 of the impeller 1, a straight trailing edge U, parallel to the axis 6 of the impeller 1, a root 7 attached to the 4 and an end 8 connected to the ring 5.

The angle β at which the leading edge 4 is inclined may range from 0 degrees, in the case of rectangular blades 3, to 40 ~~(sexagesimal)~~ degrees.

The rectangular or trapezoidal shape of the blades 3 depends on the type of performance required: rectangular blades provide improved capacity, while trapezoidal blades achieve greater head and better acoustic properties.

A preferred value for the angle β, which provides excellent performance in terms of capacity, pressure head and acoustic properties is 12.65 degrees.

The blade 3 extends for a length L, the profile of the blade 3 has a straightened length W1, measured along the centre line of the profile, at the root 7, and a straightened length W2 at the end 8.

The lengths W1, W2 of the profiles expressed as ratios of the length L are the following:

W2 between 0.3 and 0.5 of the length L, preferably 0.35;

W1 between 0.3 and 0.8 of the length L, preferably 0.70.

Figures 4 and 5 illustrate sections of the blade 3 profile at the root 7 and at the end 8, respectively.

The curvature of the centre line 9 of the profile at the root 7 is defined by the equation

$$Y = Y_0 + \bar{a}_1(x-x_0) + \bar{b}_1(x-x_0)^2 + \bar{c}_1(x-x_0)^3 + \bar{d}_1(x-x_0)^4$$

where $\bar{a}_1 = -\frac{1}{95{,}6}$; $\bar{b}_1 = \frac{1}{27{,}9}$; $\bar{c}_1 = -\frac{1}{61500}$; $\bar{d}_1 = \frac{1}{32300}$.

The profile has a chord C1 of 21.488 mm, a constant

thickness S1 of 1.1 mm and a camber f1 of 4.20306 mm between the centre line 9 and the chord C1.

The curvature of the centre line 10 of the profile at the end 8 is also defined by the equation

$$Y=Y_0+\bar{a}_1(x-x_0)+\bar{b}_1(x-x_0)^2+\bar{c}_1(x-x_0)^3+\bar{d}_1(x-x_0)^4$$

where the constants are the same as those stated above.

The profile has a chord C2 of 14.154 mm, a constant thickness S2 of 1.1 mm and a camber f2 of 1.5033 mm.

The cambers f1 and f2 are approximately half way along the respective chords C1 and C2, these positions being specified by the values lf1, lf2 in the table below.

The values of thickness S1, S2 and of camber f1, f2 of the profiles expressed in relation to the chords C1 and C2 are the following:

S1 between 5% and 8% of the chord length C1, preferably 6%;

f1 between 10% and 15% of the chord length C1, preferably 12%;

S2 between 6% and 10% of the chord length C2, preferably 8%;

f2 between 10% and 15% of the chord length C2, preferably 12%.

The chord C1 of the profile at the root 7 makes an angle γ1 with the radius R1 measured at the leading edge A. The angle γ1 may range from 50 to 80 ~~(sexagesimal)~~ degrees and is preferably 65.2 degrees.

The chord C2 of the profile at the end 8 makes an angle γ2 with the radius R2 measured at the leading edge A. The angle γ2 may range from 33 to 63 ~~(sexagesimal)~~ degrees and is preferably 48.2 degrees.

The description below refers to a preferred embodiment of an impeller according to the present invention without restricting the scope of the inventive concept. The impeller 1 illustrated in the accompanying drawings is made up of two symmetrical modules 2 with lateral suction.

Each module 2 has twenty-eight blades, which are offset with

Claims

1. A centrifugal fan impeller (1) having an axis of rotation (6) and comprising one or more modules (2), each module (2) comprising a mounting disc (4), at least one connecting ring (5) and a plurality of blades (3) extending between the mounting disc (4) and the connecting ring (5), the blades (3) being connected to the disc (4) and ring (5) at an angle (α) relative to the axis (6) of the impeller (1), the impeller being characterised in that the angle (α) at which the blades (3) are inclined is 10 degrees, in that the connecting ring (5) is positioned on an outer diameter in respect to the blades (3), whereby the inner part of the mould for producing the fan impeller (1) can be extracted axially from both sides of the fan impeller (1),
in that the profile of each blade (3) at the root is inclined at an angle ($\gamma 1$) ranging from 50 to 80 degrees,
and in that the profile of each blade (3) at the end is inclined at an angle ($\gamma 2$) ranging from 33 to 63 degrees, said angles ($\gamma 1$, $\gamma 2$) at the root (7) and at the end (8) of the blade (3) being defined as the angles made by the profile of the blade (3), at the root and end of the blade respectively, with respect to an impeller radius (R1, R2) passing through the leading edge (4) of the profile.

2. The impeller according to claim 1, characterised in that each blade (3) is substantially trapezoidal in shape when seen in a straightened plan view.

3. The impeller according to claim 1, characterised in that each blade (3) is substantially rectangular in shape when seen in a straightened plan view.

4. The impeller according to claim 2, characterised in that each blade (3) has a straight leading edge (A) inclined at an angle (β) ranging from 0 to 40 degrees with respect to the axis (6) of the impeller (1).

5. The impeller according to claim 2, characterised in that each blade (3) has a straight trailing edge (U) parallel to the axis (6) of the impeller (1).

6. The impeller according to claim 2, characterised in that each blade (3) has a straight leading edge (A) inclined at an angle (β) of 12.65 degrees with respect to the axis (6) of the impeller (1).

7. The impeller according to any of the foregoing claims, characterised in that the profile of each blade (3) at the root is inclined at an angle ($\gamma 1$) of 65.2 degrees.

8. The impeller according to any of the foregoing claims, characterised in that the profile of each blade (3) at the end is inclined at an angle ($\gamma 2$) of 48.2 degrees.